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(19)

(54) BROAD BAND DYNAMIC LOUDSPEAKER

(71) We BABBCO LTD., a limited partnership of the State of Texas, of 608 Business Parkway, Richardson, Texas 75080, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates generally to loudspeakers, and more particularly, to a dynamic loudspeaker which operates over a wide band of audio frequencies.

According to the present invention there is provided a loudspeaker comprising:

a frame;

a magnetic assembly supported by the frame, the magnetic assembly including a centre pole and an outer pole disposed around the centre pole to form an annular flux gap therebetween, the centre pole having a free forward end;

a coil assembly including a tubular voice coil disposed for reciprocal movement in the annular flux gap;

means extending forward from the coil assembly and peripherally suspended by the frame for radiating acoustic energy in response to the reciprocal movement of the voice coil, said radiating means including a centrally located cap disposed forward from the free forward end of the centre pole, a generally frustoconical shaped speaker cone adjoining the cap and flaring radially outward and axially forward from the cap, and a plurality of sound transmitting ribs rigidly adjoining and extending radially along the forward surfaces of the cap and speaker cone, each rib having an inner portion adjoining the cap and an outer portion adjoining the speaker cone, whereby the ribs impart structural stability to the radiating means.

It is preferred that the members of the coil assembly including the voice coil are radially flexible, whereby the tubular shape of the voice coil is maintained by the acoustic radiating means.

The nature of the invention, its features and advantages as set forth above, may be understood more fully upon the consideration of particular embodiments. The following is a description of preferred embodiments and how to make and use them. It is to be read in conjunction with the accompanying drawings, wherein:

Figure 1 is a perspective view of a loudspeaker according to the invention;

Figure 2 is a frontal elevation of the loudspeaker;

Figure 3 is a sectional view showing internal features of the loudspeaker with the moving assembly shown near the forward limit of its normal excursion;

Figure 4 is an expanded section, to scale, of a rib on the speaker cone.

Figure 1 illustrates the general exterior appearance of a loudspeaker in accordance with the invention. The speaker is indicated generally by the reference numeral 30. At the rear of the speaker is a magnetic assembly, indicated by reference numeral 31. Mounted on the magnetic assembly is the frame or "basket" 32 in which is suspended a paper speaker cone 34. Projecting from the cone and from a dust cap 72 are ribs 38. The distribution of the ribs 38 on the cone and dust cap are shown somewhat more clearly in the frontal view of Figure 2.

The internal structure of the speaker is shown in Figure 3. The figure is substantially to scale. The magnetic assembly is seen to be composed of three pieces. A magnetic plate 40 with a cylindrical aperture 42 is magnetized so that one pole is on surface 44 of the plate and the other pole is on surface 46. Pole piece 48 has a plate portion 50 adjoining magnetic plate 40 at surface 44, and a cylindrical centre pole which extends through aperture 42. A plate-shaped pole

piece 54 adjoins magnetic plate 40 at surface 46. Pole piece 54 has a cylindrical aperture 56 through which centre pole 52 extends. The lines of magnetic flux from magnetic plate 40 extend across surfaces 44 and 46, through the pole pieces 48 and 54, and across the annular air gap 58, which is between pole piece 54 and centre post 52. In a preferred embodiment, the width of the air gap 58 is 0.048 inches, and the diameter of the centre post 52 is 1.4 inches. The moving parts of the speaker, i.e. a flexible coil assembly 59 and cone assembly including the cone 34, dust cap 72 and ribs 38 are illustrated in a forward position of travel in Figure 3.

The cylinder 62 is bonded to the speaker cone 34. The periphery of cone 34 is attached to an annular rolled edge seal 70. The seal 70, which is preferably formed of polyurethane foam, is mounted along its outer periphery on basket 32.

The dust cap 72 is of a generally conical shape so that the peripheral edge 74 at the base of the conical surface is circular. This circular edge 74 is joined along its perimeter to speaker cone 34 by a suitable cement or adhesive.

Each of the ribs 38 is attached both to speaker cone 34 and to dust cap 72, and this is coupled to the coil assembly. Each of the ribs 38 is planar and is preferably die stamped from sheet material. Figure 3 shows exactly, for two of the ribs, the shape of the planar surface. Figure 4 illustrates how the planar surface of each of the ribs 38 is mounted normal to the surface of the speaker cone 34 and of dust cap 72, and is also drawn to scale to illustrate the extreme axial dimension of the ribs with respect to the thickness of the ribs and the thickness of the cone. In a preferred embodiment, for example, the thickness of the ribs 38 is about 0.005 inch, the thickness of the cone 34 is about 0.005 inch, and the height of the ribs is about 0.250 inch.

For low frequency operation, the ribs allow a very light cone structure to attain a rigidity which is otherwise possible only by using a heavy, stiff paper cone. The rigidity prevents buckling of the cone during large low frequency excursions and minimizes spurious modes of vibration in the cone. At high frequencies, each rib couples the high frequency energy from paper cylinder 62 to cone 34 all along the base of the rib. The resulting wavelets of acoustical energy radiated at various points along one of the ribs 38 are substantially in phase with one another, minimizing cancellation effects. The amount of high frequency energy radiated can be adjusted by varying the number of ribs, the length of the ribs, and the height of the ribs, i.e. the axial dimension of the ribs.

The portions of the ribs 38 that lie on dust cap 72 perform at least two functions. First, they transmit high frequency energy to dust cap 72 in the same manner as it is transmitted to cone 34. The result is to increase the effective high frequency radiating area. Second, when the ribs 38 are extended onto the dust cap 72, the structure composed of cone, ribs and dust cap becomes a considerably more rigid unit. This is particularly important because the flexible coil structure 59 is not the source of structural stability that a conventional stiff coil form would be. Referring to Figure 3, it can be seen that there is some opportunity for the flexible wall of coil structure 59 to move in rotation about edge 74. If this happens, the nearby portion of cone 34 tends to rotate in the same direction about the edge 74. The portion of ribs 38 on dust cap 72 oppose this motion. If dust cap 72 were flat rather than conical, the rigidity attained would not be as great. The forces on the flat dust cap would be largely normal to its surface, and it would readily bend to them. In the protruding configuration shown, if a portion of the cone 34 tends to rotate about edge 74, the movement is opposed by stretching forces in the plane of the material near the apex of the conical dust cap 72.

It is envisioned within the broader aspects of this invention that the cone 34, dust cap 72, and ribs 38 may not be fabricated separately and assembled as generally described herein. Any two or all three of these categories of items may be fabricated as a unit. They may be molded of plastics or perhaps stamped from a polymeric material such as Mylar (Trade Mark).

The reader's attention is drawn to our co-pending application 11817/77 (Serial No. 1574855) from which this application was divided.

WHAT WE CLAIM IS:

1. A loudspeaker comprising:

a frame;

a magnetic assembly supported by the frame, the magnetic assembly including a centre pole and an outer pole disposed around the centre pole to form an annular flux gap therebetween, the centre pole having a free forward end;

a coil assembly including a tubular voice coil disposed for reciprocal movement in the annular flux gap;

means extending forward from the coil assembly and peripherally suspended by the frame for radiating acoustic energy in response to the reciprocal movement of the voice coil, said radiating means including a centrally located cap disposed forward from the free forward end of the centre pole, a generally frustoconical shaped speaker cone adjoining the cap and flaring radially outward and axially forward from the cap, and

a plurality of sound transmitting ribs rigidly adjoining and extending radially along the forward surfaces of the cap and speaker cone, each rib having an inner portion adjoining the cap and an outer portion adjoining the speaker cone, whereby the ribs impart structural stability to the radiating means.

2. A loudspeaker according to claim 1 wherein the cap is generally conical in shape and flares radially outward and axially rearward from its apex toward the adjoining surfaces of the speaker cone.

3. A loudspeaker according to claims 1 or 2 wherein the ribs have a dimension normal to the adjoining surfaces of the cap and speaker cone that is much greater than its thickness dimension.

4. A loudspeaker according to claim 3 wherein the rib thickness is approximately equal to the thickness of the speaker cone.

5. A loudspeaker according to any of claims 1 to 4 wherein the speaker cone consists essentially of paper.

6. A loudspeaker according to claim 5 wherein the ribs each comprise plastics material having a thickness of about 0.005 inch.

7. A loudspeaker according to any of claims 1 to 6 wherein the members of the coil assembly including the voice coil are radially flexible, whereby the tubular shape of the voice coil is maintained by the acoustic radiating means.

8. A loudspeaker according to claim 1 substantially as hereinbefore described with reference to the accompanying drawings.

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1574856 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

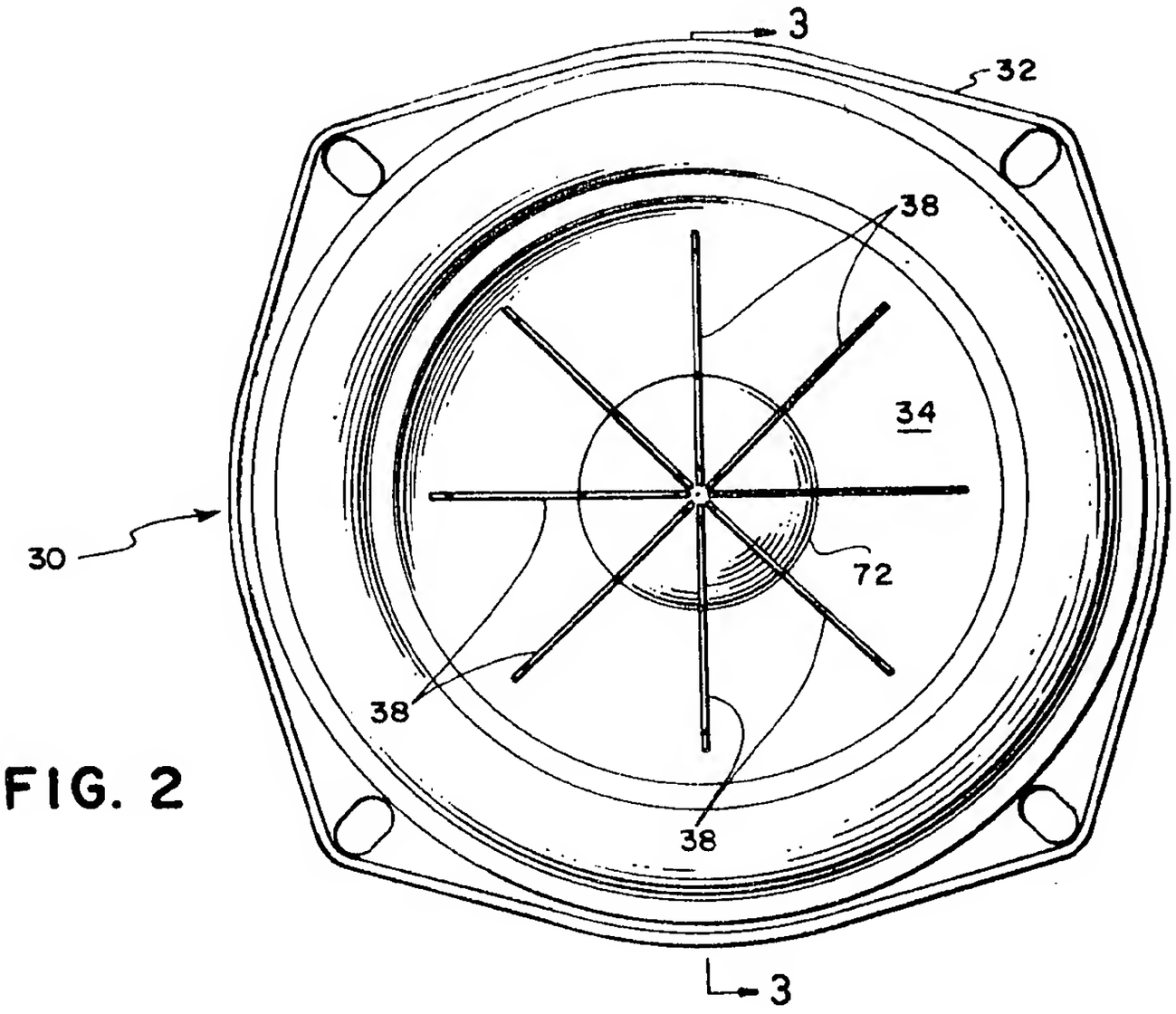

FIG. 2

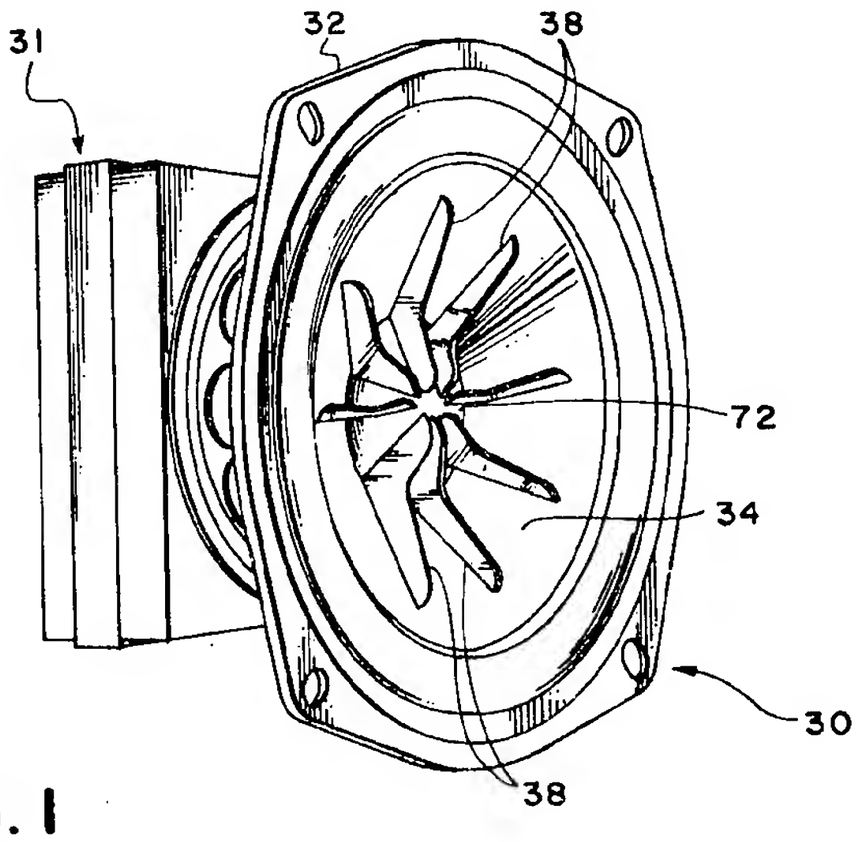

FIG. 1

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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

FIG. 3

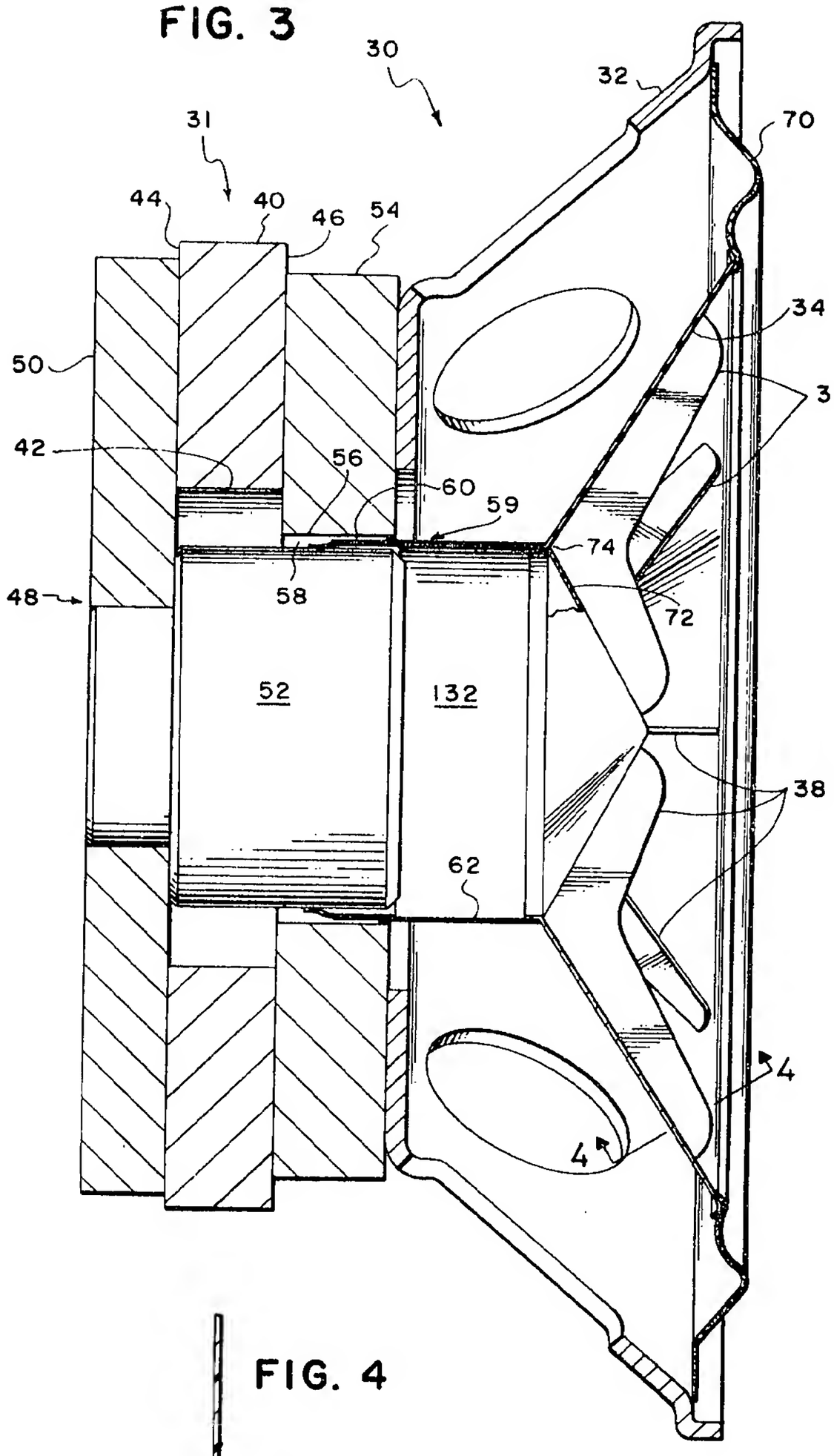

FIG. 4